

DSN Research and Technology Support

E. B. Jackson
RF Systems Development Section

The activities of the Venus Deep Space Station (DSS 13) and the Microwave Test Facility (MTF) during the period Feb. 16 through April 18, 1976 are discussed and progress noted.

Continuing testing and refinement of the remote-controlled, unattended automated pulsar observing station is noted, along with routine pulsar observations of 22 pulsars. Radar observations of a geo-stationary satellite are discussed. Current status of the 400-kW X-band radar is reported along with routine automatic testing of the stability-reliability of the DSS 13 maser-receiver noise adding radiometer combination. A failure in the Faraday Rotation Receiving System is noted along with discussion in some detail of the activities of the High Power Transmitter Maintenance Facility. Continuation of receiver phase stability testing, specifically the effects of temperature on coaxial cables, is discussed and results reported.

A demonstration at full power of the microwave power transmission facility is noted and routine support of the Planetary Radio Astronomy experiment is discussed. Transmission of master clock synchronization signals to overseas DSN stations is also reported.

The activities of the Development Support Group, in operating the Venus Deep Space Station (DSS 13) and the Microwave Test Facility (MTF) during the period Feb. 16 through April 18, 1976, supported various programs as discussed below.

I. Station Automation

In support of RTOP 70 "Network Monitor, Control and Operations Technology," DSS 13 will be the prototype to demonstrate an unattended remotely operated station.

Including automated tracking, 26-3/4 hours of station support were provided. Automated tracking, directed from the on-site master control computer, was performed during a 6-1/2 hour period during which data were collected from Pulsars 0031 - 07, 0329 + 54, 0355 + 54, and 1929 + 10. Except for operator input to the master control computer, directing which target was to be tracked, no operator intervention was necessary. The antenna movement, receiver tuning, and data collection are performed automatically under the control of the three computers. Katherine Moyd and Stanley Brokl, Section 331, assisted by Conrad Foster, Section 335, and supported by station personnel have been performing this testing.

II. Pulsar Observations

In support of the Radio Science Experiment "Pulsar Rotation Constancy" (OSS-188-41-51-09), DSS 13 provided 88 hours of observations during which the emissions from the pulsars listed below were recorded. These data, recorded at 2388 MHz, left-circular polarization (LCP), are used to determine precise pulse-to-pulse spacing, changes in this spacing, pulse shape, and pulse power content of the signals emitted by these pulsars.

The following pulsars were observed at DSS 13, Feb. 16 through April 18, 1976:

0031-07	0823+26	1706-16	2021+51
0329+54	0833-45	1749-28	2045-16
0355+54	1133+16	1818-04	2111+46
0525+21	1237+25	1911-04	2218+47
0629-28	1604-00	1929+10	
0736-40	1642-03	1933+16	

III. Radar Observations, Satellite

With the Mars Deep Space Station (DSS 14) transmitting and DSS 13 receiving, reflected signal radar observations are being made of a geostationary satellite. Using the DSS 14 64-m antenna, the satellite is illuminated with the 400-kW S-band transmitter at a nominal frequency of 2388 MHz, with reception of the reflected signal being accomplished on alternate round-trip light-times by DSS 13, using a programmed oscillator-controlled receiver and a 26-m antenna. Two stations are necessary because the round-trip light-time (RTLTL) is so short

(approximately 242 ms) that waveguide switching is impractical. The transmitting station switches frequency approximately 2 MHz every RTLTL and the receiving station can receive the reflected signal every other RTLTL. Although the apparent radar cross section is small, reflected signals have been detected from the satellite. A total of 17-1/4 hours of tracking have been conducted.

IV. X-Band Radar

Operational power available has continued to be increased, until 400 kW was made available early in the reporting period. In addition to providing support to increase available power, and operational support at DSS 14 during tracking, work has also continued on documentation and instruction manuals, including operations instructions. The 5th klystron, VA-949J, has now been received and a full complement of klystrons is now available for use as necessary.

V. Maser-Receiver-NAR Reliability-Stability Testing

Reliability and stability testing of the DSS 13 total receiving system is conducted automatically during non-operational and nonmanned station periods. The 26-m antenna is prepositioned to a fixed azimuth and elevation and the noise adding radiometer (NAR) automatically records total receiving system temperature as a function of time. A radio brightness sky map is generated by Earth's rotation sweeping the fixed antenna across the sky as an additional data output from this testing. During this reporting period, the antenna was positioned at 360 deg azimuth and progressively positioned from 51.5 to 50.8 deg elevation and 491-3/4 hours of testing were automatically performed. This testing is done at 2295 MHz using right circular polarization (RCP) on the 26-m antenna.

VI. Faraday Rotation Experiment

This experiment, which collects ionospheric data with which to correct received range and doppler data from spacecraft, consists of two complete receiving systems, recording onto punched paper tape. Due to heavy rains, one of the systems failed when water entered the antenna-mounted preamplifier. The receiver was repaired by Section 333 personnel, returned to DSS 13, and has now been reinstalled.

VII. Deep Space Network High-Power Transmitter Maintenance Facility (DSN HPTMF)

The DSN HPTMF, located at DSS 13 and at MTF, continued to support the 10, 20, 100 and 400-kW transmitters used in the DSN, with particular emphasis on the 100 and 400-kW transmitters and the 10-kW klystrons.

Klystron 4KM70SI, Serial Number F7-1, was tested to verify its ability to develop 10-kW output RF power. Additionally, bandpass curves and confirmation of the manufacturer's test data were obtained. The klystron was then shipped to DSS 62 in Spain for installation as necessary.

An X-3060 klystron, returned from DSS 63 in Spain, was tested and reported thermal drift in output power was confirmed. Consultation with the manufacturer (Varian Associates) is underway about possible on-site corrective measures.

The kit to effect installation of a 100-kW klystron into DSS 14 was completed and utilized after the failure (partially shorted filament) of the X-3075 klystron used in the DSN transmitter. Also for DSS 14, the second dual ignitron kit was tested for 12 hours at 60 kV to insure operability. Both dual ignitron kits have been modified to utilize the armored fiber optics that reduce the possibility of fiber breakage as a result of improper handling.

As a result of a recommendation by Varian Associates, four socket tanks for X-3070 and X-3075 klystrons have been modified to power the filaments with alternating current rather than direct current, which has been used in the past. Prior to this modification being implemented, a high-resolution spectrum analysis of the output RF carrier was performed to ascertain if use of alternating current would phase modulate the carrier. Using a variable frequency power supply, the socket tank was operated on 350 Hz to separate any generated modulation from 400-Hz modulation possibly present from HV power supply ripple. A spectrum analysis confirmed the presence of both 350 and 400 Hz sidebands. However, the amplitude was quite low, the 400 Hz HV power supply ripple modulation being 55 dB below the 100-kW carrier and the 350-Hz filament modulation being 63 dB below the 100 kW carrier. Both levels were undetectable in ordinary operation.

Following up on the 400-Hz sidebands observed to be due to DSS 13 HV power supply ripple, a high-resolution

spectrum analysis was also performed on the dc output from this power supply. Operating at an output voltage of 20 kV, and using a 1,000::1 high-voltage probe, the spectrum shown in Fig. 1 was obtained. The strongest ripple frequency component, 400 Hz, represents approximately 0.1% of the dc output voltage of 20 kV. Harmonics of 400 Hz are clearly seen at higher frequencies, although the amplitude falls off rapidly above 5 kHz. Further testing is underway.

VIII. Diplexer Testing, High Power

A DSN diplexer, fabricated by a new technique, was tested at an operating power of 100 kW to verify its freedom from noise bursting effects. This test, and the results, are described in detail elsewhere in this issue by Richard B. Kolbly.

IX. Receiver Phase Stability Testing

An investigation into the phase stability characteristics of coaxial cable is continuing (Ref. 1). A test cable of 30-m length has been carefully wound into a coil 38 cm in diameter by taking unused cable directly from the manufacturer's shipping reel. After forming into a coil, connectors were attached using the manufacturer's dimensions and instructions. Using 2272 MHz, derived from a stable source, as an excitation frequency, continuous recording of electrical length was accomplished while the cable temperature was cycled from 0° to 50°C in a temperature chamber. Typical data records are shown in Figs. 2 and 3. The manufacturer suggests that, for maximum phase stability, coaxial cable should be cycled over the planned range of temperature usage several times before measurement or usage. Data taken during this series of measurements confirm the validity of this recommendation. Where possible, all semiflexible coaxial cables intended for usages where phase stability is important, should be cycled over the maximum temperature extremes expected, a minimum of six times, allowing for temperature stabilization at each extreme of temperature.

Using an excitation frequency of 100 MHz, electrical length measurements were also made on an installed semiflexible coaxial cable loop at DSS 14, using ambient temperature to effect cable temperature changes. However, much of this cable installation is in the tunnel between Control Building and Antenna, and little overall temperature change takes place. Over a very limited temperature range in the vicinity of 0°C, the phase stability of the chosen cable loop is 0.42 degrees of phase/degree Celsius temperature change, at 100 MHz.

X. Microwave Power Transmission

Using radiated powers up to 300 kW at 2388 MHz, the 26-m antenna illuminated the collimation tower mounted rectenna in a demonstration of capability. The observing group consisted of William Bayley, Mahlon Easterling, and Robert MacMillin of JPL and John Wilford of the New York Times. Recovered dc power of approximately 30 kW was obtained from the rectenna, mounted 1.6 km away from the transmitting antenna.

XI. Planetary Radio Astronomy

In support of the radio science experiment "Planetary Radio Astronomy" (OSS 196-41-73-01), DSS 13 measures and records the radiation received (at 2295 MHz) from the planet Jupiter and various standard radio calibration sources. These measurements use the 26-m antenna, the DSS 13 receiving system, and the Noise Adding Radi-

ometer (NAR). During this period 66-1/2 hours of observations were made, from Feb. 16 through April 18, 1976, measuring the radiation from Jupiter and the following calibration sources:

3C17	3C138	NRAO 530
3C45	3C147	PKS 0237-23
3C48	3C348	PKS 2134
3C123	3C353	

XII. Clock Synchronization System

Failure of a generator field excitation power supply forced postponement of a scheduled transmission to DSS 42 in Australia. Operation was otherwise uneventful. A total of ten transmissions were made with DSN scheduling, six to DSS 42-43 in Australia and four to DSS 61-63 in Spain.

Reference

1. Buchanan, H. R., and Price, A. L., "Temperature Effects on Transmission Line Phase and Group Delay," in *The Deep Space Network Progress Report 42-32*, pp. 296-300, Jet Propulsion Laboratory, Pasadena, Calif., April 15, 1976.

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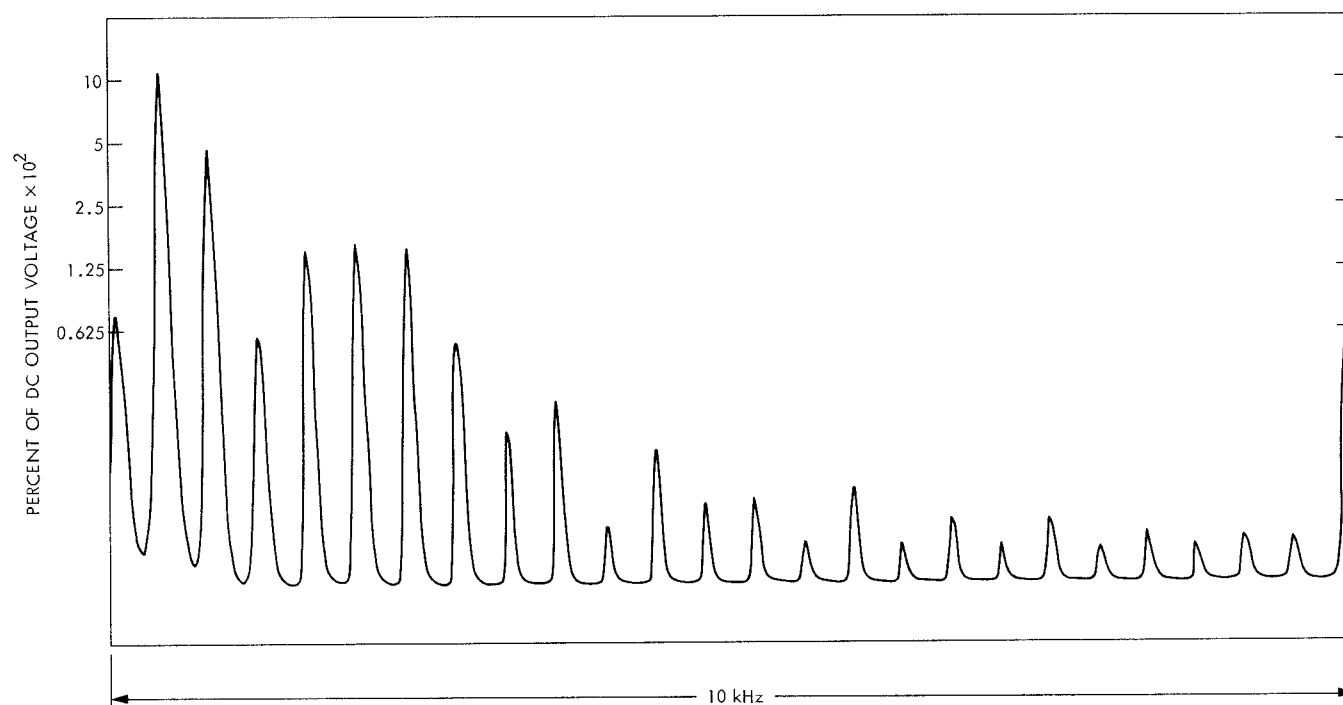


Fig. 1. DSS 13 HV DC power supply ripple voltage spectrum analysis 20 kV DC output voltage

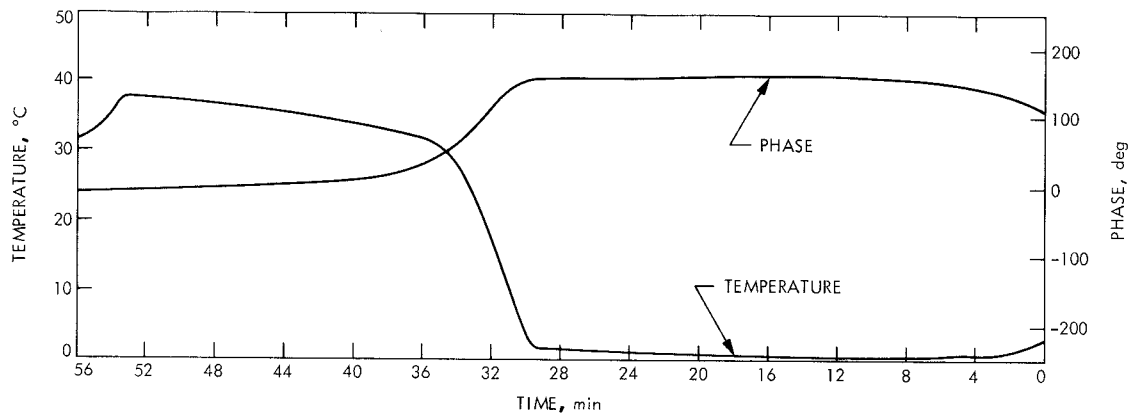


Fig. 2. 30-m test cable, differential electrical length first cycle in temperature chamber

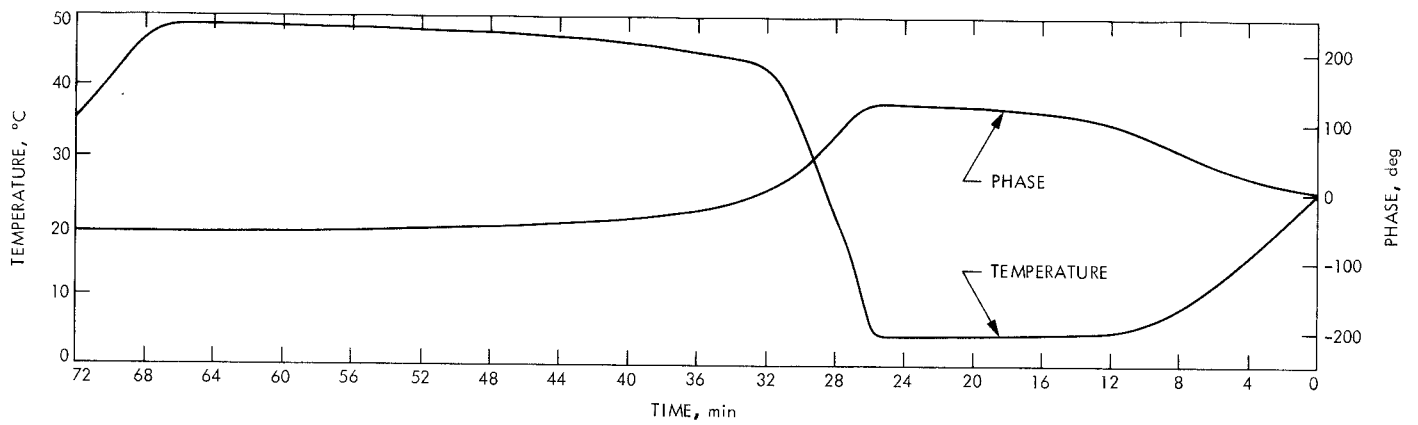


Fig. 3. 30-m test cable, differential electrical length fifth cycle in temperature chamber